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ABSTRACT

Aims of this phase of a longitudinal mathematics achievement investigation were to (1) detect individual and group differences in math achievement among a sample of fourth-year children, (2) monitor changes in math skills since a 1981 math investigation, and (3) identify limits of children's understanding of mathematical concepts. (The math test itself was designed to be additionally suitable for use in 1983.) An item bank was assembled by combining those items which the fewest children answered correctly on the 1981 test with items assessing skill in operations for counting numbers at fourth-year level and above. Items tested content area skill and three aspects of problem structure: number size, position of the answer box or missing element, and problem format. The resulting test consisted of six subscales, including addition, subtraction, multiplication, concepts, word problems, and number problems paralleling the word problems. Altogether, 692 children in 33 fourth-year classes were tested; subjects attended 5 Mt. Druitt schools and 3 contrast schools. Findings indicated significant achievement differences between subsamples and among schools on all subscales and on the total test. Longitudinal change was found on the 11 items common to the 1981 and 1982 tests, and sample-wide error patterns emerged from the data. The test and instructions for administration are appended. (RH)

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MT. DRUITT LONGITUDINAL STUDY

SCHOOL OF EDUCATION MACQUARIE UNIVERSITY, NORTH RYDE, AUSTRALIA 2113

1982 Maths Investigation: Technical Report

By

Karen Houghton and Brian Low

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FOREWORD

Since late 1975, the Macquarie University School of Education has conducted research in the Mt Druitt area of Sydney. Funded by the Bernard van Leer Foundation, it has designed and directed two educational projects: the Mt Druitt Early Childhood Project (1975-1980); and the Mt Druitt Longitudinal Study (1981 to present). Both the N.S.W. State Government and the Australian Federal Government provided additional funds for the earlier Project while the Federal Government has also provided some funding for the Longitudinal Study.

Mt Druitt is a dormitory suburb thirty five to forty five kilometres west of Sydney's central business district. It has a population of about ninety thousand people, ninety percent of whom are accommodated in State Government Housing Commission dwellings. In 1975 it was identified by six governmental or social welfare agencies as amongst the most socially disadvantaged areas in N.S.W. The occurrence of single parent family units and rates of unemployment, family breakdown, youth delinquency and reliance on social welfare payments in Mt Druitt are as great as or greater than anywhere else in N.S.W. The Mt Druitt Early Childhood Project and the Mt Druitt Longitudinal Study represent attempts by Macquarie University School of Education to address the problem of educational disadvantage experienced by children in Mt. Druitt.

The Mt Druitt Early Childhood Project was an action research project which implemented and evaluated five different early childhood programs for disadvantaged children. Each program was based on a different child development theory and was implemented in a different government school in Mt Druitt. The programs were directed at a group of children as it progressed from Pre-school to Kindergarten and Year 1. The focus was on effective curriculum and teaching, and on their outcomes for disadvantaged children.

The Mt Druitt Longitudinal Study is a pilot longitudinal survey of the physical, social, psychological and educational development of the two hundred children remaining from the Early Childhood Project and of six hundred contrasting children. The additional six hundred children are either the present classmates of the two hundred Early Childhood Project children or children in three different Sydney sites outside Mt Druitt.

One aspect of the Project's initiatives in the education of the disadvantaged children is the design and implementation of mathematics programs (Early Childhood Project), the evaluation of maths achievement, and the provision of diagnostic information to teachers.

In the following report, prepared by Karen Houghton, a Senior Research Assistant in the Longitudinal Study, the latest findings on the development of maths skills are presented.

P O'Brien

Peter O'Brien, Ph.D.
Field Director,
August, 1982.

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TECHNICAL REPORT ON 1982 MATHS INVESTIGATION

This report is a technical description of the maths achievement investigation carried out by the Mt Druitt Longitudinal Study in 1982. The Investigation is one strand of the Study's research into the social, psychological and educational development of children in Mt Druitt. It was designed specifically to expand the Study's longitudinal data bank about the academic skills of Mt Druitt children who are presently in Year 4.

The maths achievement investigation involved the design and administration of a pencil and paper maths test, and the analysis of its results. Its aims were:

- to describe or detect any individual and group differences in maths achievement among the Study's sample of Year 4 children.
- to monitor change in maths skills since the 1981 maths investigation, and to be suitable for the same use in 1983.
- to identify the quality or limits of the children's understanding of mathematical concepts.

TEST DESIGN

The test design implications of the above aims were:

- the Test should differentiate maximally among individuals;
- the Test should incorporate those items from the 1981 maths test which had the greatest potential for improved performance;
- the Test should investigate a wide variety of maths skills and concepts (amenable to testing) and have a sufficiently high ceiling to permit the Test's use again on the sample in 1983.

A norm-referenced test was adopted as the appropriate way to emphasize individual differences in achievement. An item bank was assembled by combining those items which fewest children answered correctly in the 1981 test, with a series of items devised to test the skills of using operations on counting numbers at Year 4 and above level (as described by the NSW Education Department's Mathematics Curriculum: Primary Schools). The series of items was devised to test not only the specific content area described above, but also to test three specific aspects of problem structure which previous research had identified as developmentally significant. The three structural aspects were: number size (Collis, 1975); the position of the missing element or answer box (Lunzer, Bell & Shiu, 1976); and the problem format (i.e. word or number format). The item bank comprised sets of items parallel in content but divergent in one of these three structural aspects. All items in the data bank were trialled on a sample of 90 children who comprised the entire year 4 enrolment at a Mt Druitt school not in the Study. The trial identified several

poor items. These were modified or omitted, and the result was an 83 item maths test.

Test Specifications

The Test was structured to incorporate six subscales: addition; subtraction; multiplication; concepts; word problems; and number problems parallel to these word problems. The Test's specifications are presented in Tables 1 to 4 overleaf. Note that the word and number subscales are superordinate to the operation subscales and not presented separately.

To avoid the problem of testee fatigue, the Test was divided into four parts to be administered singly on four consecutive mornings. All parts were of equal length and item variety. A copy of the Test can be found in Appendix 1. It was planned to further refine this measure following testing, by excluding items found to be poor discriminators of maths achievement.

ADMINISTRATION

During April, the Test was administered by class teachers to all Year 4 classes in the Study's sample, except for O.A. classes. The total number of classes tested was 33. The teachers had been instructed in the use of the desired standardised test administration procedures, and were shown the Test the day before testing commenced. A copy of the written instructions distributed during training is in Appendix 2. Altogether 692 children were tested. These included the 342 girls and 350 boys who comprise the total Year 4 enrolment (minus the O.A. children) of five Mt Druitt schools and three contrast schools. The resulting protocols were scored by computer.

TABLE 1

TEST SPECIFICATIONS: ADDITION SUBSCALE

Curriculum Content	Structure			Item	Comments
	number size	box position F = first M = medial L = last	format N = number W = word	number versions only given for matched pairs	
1d + 1d	numbers less than 10	F	N	)□ + 8 = 9	1981 Test item
		F	W	)	
		F	N	□ + 2 = 7	1981 Test item
1d + 2d sum less than 49	numbers less than 50	L	N	) 8 + 33 = □	
		L	W	)	
		L	N	36 + 7 = □	omitted from final test as poor discriminator.
		M	N	)24 + □ = 33	
		M	W	)	
		F	N	) □ + 4 = 49	
		F	W	)	
		F	N	□ + 6 = 24	
1d + 2d sum greater than 48 but less than 100	numbers less than 100	L	N	)56 + 8 = □	omitted from final test as poor discriminator
		L	W	)	
		L	N	7 + 64 = □	
		M	N	)72 + □ = 81	
		M	W	)	
		M	N	49 + □ = 57	
		F	N	)□ + 5 = 63	
		F	W	)	
		F	N	□ + 8 = 80	
5 addends to one place	numbers less than 10	L	N	)2 + 3 + 5 + 2 + 7=□	omitted from final test as poor discriminator
		L	W	)	
4 addends to two places	numbers less than 100	L	N	) 13 + 8 + 24 + 9 =□	
		L	W	)	

TABLE 2

TEST SPECIFICATIONS: SUBTRACTION SUBSCALE

Curriculum Content	Structure: number size	box position	format	Item	Comments
1d - 1d	numbers less than 10	F F	N W	))□ - 7 = 1	1981 test item
1d - 0	numbers less than 10	F F	N W	)□ = 5 - 0)	1981 test item; omitted from final test as poor discriminator
2d - 1d, difference less than 20	numbers less than 28	F F F F M M	N W N W N W	)□ = 14 - 8))□ - 3 = 14))25 - □ = 18)	1981 test item.
2d-2d values less than 20	numbers less than 20	F F M M F F	N W N W N W	)□ = 18 - 12))17 - □ = 6))□ - 13 = 6)	1981 test item; omitted from final test due to typing error.
2d-2d values in range 20 to 100, no bridging decades	numbers in the range 20 to 100	L L M M F F	N W N W N W	)86 - 33 = □))65 - □ = 22))□ - 52 = 44)	
2d-2d values in the range 20 to 100, bridging decades	numbers in the range 20 to 100	L L	N M	77 - 29 = □ 60 - 35 = □	simplest box position only due to difficulty already presented by bridging
3d-3d	numbers in the range 100 to 999	L L	N N	207 - 109 = □ 463 - 276 = □	as above

TABLE 3

TEST SPECIFICATIONS: MULTIPLICATION SUBSCALE

Curriculum Content	Structure			Item	Comments
	number size	box position	format		
1d x 1d product in the range 11-20	numbers less than 10	L	N	5 x 4 = ☐	a 1981 test item
		F	N	☐ x 2 = 18	
1d x 1d products greater than 20	smaller number greater than 2	L	N	) 5 x 9 = ☐	
		L	W	)	
		L	N	) 8 x 6 = ☐	
		L	W	)	
		L	N	) 7 x 6 = ☐	
		L	W	)	
		L	N	9 x 7 = ☐	
		L	N	12 x 8 = ☐	
		M	N	4 x ☐ = 24	
2d x 1d multiplicands less than 100 multipliers less than 10	larger number greater than 9 smaller number less than 10	L	N	32 x 3 = ☐	
		L	N	44 x 5 = ☐	
		L	N	24 x 8 = ☐	
		L	N	50 x 4 = ☐	

TABLE 4

TEST SPECIFICATIONS: CONCEPTS SUBSCALE

Curriculum Content	Structure: box position	Structure: format	Item	Comments
equivalent expressions, same signs	M	N	4 + □ = 7 + 4	1981 test item
	F	N	□ + 5 = 5 + 2	1981 test item
	F	N	□ - 4 = 4 - 2	
	F	N	□ - 7 = 7 - 3	
equivalent expressions, different signs	F	N	□ + 4 = 12 - 5	
	M	N	3 + □ = 8 - 3	
missing operation	SIGN	N	17 □ 11 = 6	
	SIGN	N	5 □ 8 = 40	
	SIGN	N	72 □ 8 = 80	
Fractions 1/4 1/2 1/10 2/5	L	N	)1/4 x 12 = □	1981 test item
	L	W	)	
	L	N	)1/2 x 16 = □	1981 test item
	L	W	)	
	L	N	)2/5 x 10 = □	
	L	W	)	
	L	N	)1/10 x 20 = □	
	L	W	)	

DATA ANALYSIS

Test Analysis

As a preliminary to the use of the Test as a maths achievement measure, several analyses were performed on the test data to check that the overall Test could be regarded as a measure of maths achievement viewed as a single latent trait. Each of the four subscales was similarly checked as a preparation for later analysis of interaction between content areas and various independent variables.

A normal ogive one parameter model and two parameter model (Lord and Novick, 1974) were applied to the test data using the NOHARM program (McDonald, 1980). No difference in the results for the two models emerged, so the simpler, one parameter model was preferred. It proved to be a good fit for most of the 82 items (one of the original 83 items being excluded from the analysis when it was found to contain a typing error), and for most items in each subscale. The normal ogive item characteristics were examined to identify any items with values outside the 2 standard deviation range on a normal ogive curve. The five items in Table 5 were identified and consequently removed from the Test as poor discriminators.

TABLE 5

Rejected Items and their Normal Ogive Item Characteristics

ITEM	μ	σ
36 + 7 = □	-3.589	2.497
2 + 3 + 5 + 2 + 7 = □	-3.433	2.204
56 + 8 = □	-2.680	2.128
83 - 33 = □	-2.590	2.245
□ = 5 - 0	-2.027	3.311

To determine whether the word format discriminated against poor readers in the sample (and hence tested reading skill rather than maths skill), separate subscores for word problems and number problems were computed and compared with existing data on the sample's reading achievement (ACER scores on Word Comprehension and Word Knowledge). The correlation coefficients for number subscore and reading scores were the same as for word problems and reading scores. This indicated that both the word items and their corresponding number items were measuring related skills and the word format did not discriminate against poor readers. Hence, performance on the word subscale could be compared with that on the number subscale to ascertain the relative difficulty of different problem formats.

The refined test and final measure adopted for subsequent analysis consisted of: the whole test of 77 items measuring a single latent trait called maths achievement; a subscale of 22 items measuring a single latent trait called addition skill; a subscale of 23 items measuring a single latent trait called subtraction skill; a subscale of 15 items measuring a single latent trait called multiplication skill; a subscale of 17 items measuring a single latent trait called concepts;a subscale of 26 items measuring a single latent trait called word problems; 26 items measuring a single latent trait called number problems. Note that some items omitted from the total test on the basis of their unsuitable item characteristics, were retained in the number problems subscale so that this subscale matched the word problem subscale exactly and the relative difficulty of different problem formats could be assessed.

Maths Achievement Analysis

To obtain a description of individual maths achievement, total and subtotal scores were computed for each child in the sample. These were reported to the relevant teachers in the sample and are not included here for reasons of practicality and privacy; they were also used as the dependent variable in further analyses of maths achievement.

To fulfil the investigation's aim of describing group differences in maths achievement, a series of BREAKDOWN analyses on total test scores and the various

subscale scores were performed. These analyses yielded descriptive statistics for the following groups: subsample; school; gender. The results are presented in Table 6 overleaf.

Table 6 shows that the Mt Druitt subsample of children achieved a lower average score than the Contrast subsample on the test as a whole, and on each of the subscales. ANOVA analyses confirmed that the 13 point difference between the two subsamples' mean total scores was statistically significant at the .000 level. This finding is consistent with the 1981 Maths Investigation's findings. Since a 13 point difference is equivalent to a 13 item difference, it can be described also as an educationally significant result. The Mt Druitt subsample's standard deviation from the mean was slightly higher (3 points) than the Contrast subsample's standard deviation from the mean. This finding is also consistent with the 1981 findings. The difference between the subsamples' mean score on each of the four operations varied in a 3 point range. The minimum difference was obtained for subtraction and the maximum for concepts. In both cases, there was no difference in standard deviation values.

Table 6 also shows that school group means for total score varied within a 23 point range. Subscores also varied with school group. ANOVA analyses confirmed that school group was a statistically significant main effect (at the .000 level) on total score and subscores. To determine where the significant differences lie among the school means, multiple classification analyses (Scheffe procedure) were performed on the total score and subscores. The results indicated that, at the .05 level, two Contrast schools were significantly different from each other in total score, subtraction, multiplication and concepts. Significant differences did not occur within the Mt Druitt subsample. This subsample emerged as homogeneous in maths achievement. One Contrast school's mean total score was significantly different to each of the Mt Druitt schools. Another Contrast school's total score was significantly different to all but one Mt Druitt school. The third Contrast school's total score differed significantly from only two Mt Druitt schools. The school group standard deviation from the mean was consistently higher within the Mt Druitt subsample than within the Contrast subsample, indicating more variable individual achievement among Mt Druitt children.

Fewer significant differences were found among the operation subscores for all eight schools. However, the subscores of each Contrast school differed significantly from at least two Mt Druitt schools. The greatest difference emerged on the concepts subscore, and the results are reported overleaf in Table 7.

No statistically significant gender differences were found on the total test scores or subscores. Neither were any statistically significant differences found between the total test scores of the 153 Mt Druitt children who were formerly preschoolers in the Early Childhood Project and the 44 who were formerly non-preschoolers in that Project.

TABLE 6

GROUP DIFFERENCES IN MATHS ACHIEVEMENT

GROUPS	N	ACHIEVEMENT SCORES													
		Total (Max = 77)		Addition (Max = 22)		Subtraction (Max = 23)		Multiplication (Max = 15)		Concepts (Max = 17)		Word Problems (Max = 26)		Number Problems (Max = 26)	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Means	s.d.	Mean	s.d.	Mean	s.d.
Mt Druitt Subsample	472	46.37	15.28	16.17	4.85	16.73	3.61	9.07	3.95	7.59	3.8	15.56	5.47	16.8	4.95
School 1	89	41.72	16.97	15.11	5.97	12.45	5.08	8.48	4.02	5.82	3.92	14.52	6.01	14.99	5.63
School 2	50	49.1	15.22	16.8	4.73	14.38	4.62	9.94	4.17	8.14	3.48	16.62	4.91	17.56	4.96
School 3	44	50.36	17.71	16.59	5.6	15.34	5.29	9.30	4.15	9.46	4.3	16.82	5.84	18.21	5.6
School 4	100	43.72	15.86	15.67	4.94	12.7	5.25	8.41	4.27	7.07	3.12	14.63	5.67	15.57	5.06
School 5	189	48.32	12.73	16.66	3.91	14.33	4.14	9.42	3.57	8.12	3.69	16	4.96	17.78	3.95
Contrast Subsample	218	59.17	12.57	18.82	3.53	17.06	4.25	11.99	3.13	11.73	3.96	19.89	4.55	20.63	3.99
School 7	79	59.51	9.92	19.51	2.46	16.73	3.6	11.66	2.6	12.03	3.9	20.63	3.69	20.75	3.32
School 8	66	64.85	9.35	19.7	3.03	18.96	3.5	13.82	1.39	12.82	3.73	21.32	3.87	22.17	3.2
School 9	73	53.67	15.19	17.27	4.35	15.69	4.89	10.69	3.94	10.39	3.91	17.78	5.19	19.11	4.7
Males	350	49.82	15.57	16.85	4.59	14.61	4.9	9.82	3.95	8.77	4.33	16.6	5.48	17.85	5.01
Females	342	50.92	15.86	17.11	4.75	14.94	4.94	10.15	3.97	8.99	4.28	17.25	5.65	18.12	5.04
Whole Sample	692	50.42	15.65	17	4.64	14.78	4.89	9.98	3.95	8.88	4.3	16.92	5.57	17.99	5.02

TABLE 7

MULTIPLE CLASSIFICATION ANALYSIS - SCHOOL GROUP DIFFERENCES ON CONCEPTS SUBSCORE

(* denotes pairs of groups significantly different at the .05 level)

MEAN	SCHOOL GROUP	GRPO1	GRPO4	GRPO5	GRPO2	GRPO3	GRPO9	GRPO7	GRPO8
5.6742	GRP01								
6.9400	GRP04								
7.9153	GRP05	*							
7.9800	GRP02	*							
9.1364	GRP03	*							
10.0274	GRP09	*	*	*					
11.6076	GRP07	*	*	*	*	*			
12.3788	GRP08	*	*	*	*	*	*		

Analysis of Longitudinal Change in Sample's Maths Achievement

A correlation coefficient of .8298 (significant at .000 level for N = 678) was found to exist between scores on the 1981 test and the 1982 test. This statistic indicates a high consistency of performance by the Sample.

To determine whether the Sample's level of maths achievement had changed between the 1981 and 1982 testings, total scores for the set of 11 items common to both tests were computed and compared. The results are reported below in Figure 1.

FIGURE 1

1981 and 1982 Scores on Longitudinal Items - Relative Frequency Distribution

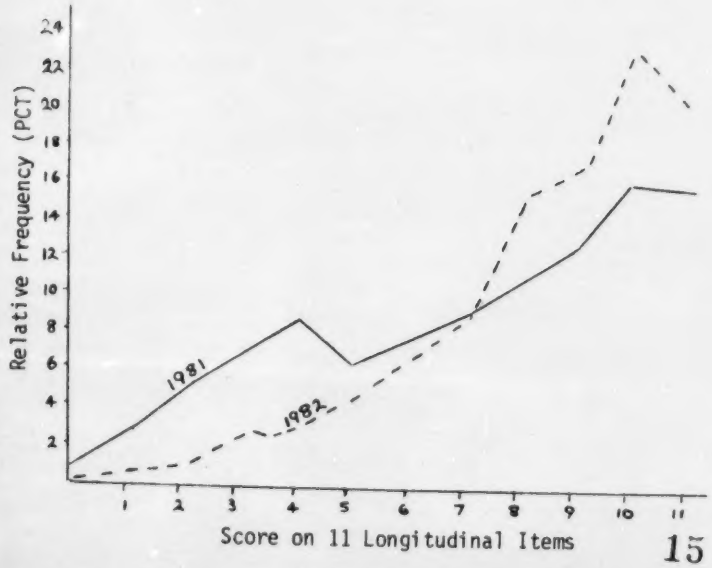

Figure 1 indicates that a small positive change in performance on the 11 items has occurred between 1981 and 1982.

A series of CROSSTABS analyses were performed to enable longitudinal comparison of achievement on individual items. Table 8 below shows that, for any item, there was a group of children whose performance improved, another whose performance declined and two further groups of children whose performance was unchanged (one group erred on both occasions, the other succeeded). However, the relative size of these groups varied with the individual item. This variation is of developmental interest because it distinguishes those items which continue to pose difficulty for the Sample from those items which have become soluble problems. Items on which large numbers of children continue to err or to decline, are beyond the level attained by the Sample in the maths skills hierarchy, e.g. 1/4 x 12 = □ and □ - 7 = 1. However, items on which small numbers of children err or decline, but large numbers improve, reflect an upward shift in the hierarchy by the Sample since 1981, e.g. □ + 8 = 9. Items, like 4 + □ = 7 + 4, which have equally high numbers improving as continuing to err, indicate that the Sample is in transition between one level and the next.

TABLE 8

Changed Performance - Whole Sample

Item	Incorrect '81 & '82	Correct '81 Incorrect '82	Incorrect '81 Correct '82	Correct '81 & '82
□ = 14 - 8	8.6	9.8	17.9	63.8
□ = 18 - 12	8.9	11.1	9.8	60.2
□ = 5 - 0	9.2	18.9	11.1	60.8
□ - 7 = 1	28.7	14.5	17	39.8
□ + 2 = 7	6.8	1.8	20.7	70.7
□ + 8 = 9	6.4	1	22.5	70.1
4 + □ = 7 + 4	24.1	5	25.1	45.7
□ + 5 = 5 + 2	23	5.6	19.4	51.5
5 x 4 = □	5.3	2.1	21	71.6
1/2 x 16 = □	10.5	3.7	16.9	68.9
1/4 x 12 = □	34.8	11.4	19.8	34

ERROR ANALYSIS

To determine the quality of errors and hence obtain information about children's conceptual difficulties, an error analysis was performed in two stages. First, a list of all error values and their frequency was obtained for each item. These lists revealed that some error values were isolated cases while others were a group phenomenon of variable size (ranging from 4 to 398). For example, error responses to the item □ - 7 = 1 included one group of 262 children, one group of 11 children, one group of 5 children and three groups of 4 children. Moreover, many of the group error values could be explained in terms of the possible ways in which children obtained them. These explanations provided the basis for an error category system and showed that most errors reflect rational attempts at problem solving.

The second stage of the analysis involved the use of this category system to summarise error data. Note that the system focuses exclusively on simple errors which occurred for large groups of children and ignores the complex errors which tended to be idiosyncratic. Two examples of simple error response categories in the system are "wrong operation" and "inaccurate computing'. An example of a complex error response excluded from the system is "combined wrong operation and inaccurate computing".

Descriptions of all simple error categories are presented below for each operation, and accompanied by relative frequency tables.

ERROR STRATEGIES: ADDITION ITEMS

Three general error strategies were found in the 22 item addition component of the 1982 Maths Test. They are listed below with examples.

1. **WRONG OPERATION OR NO OPERATION**

Here children applied an inappropriate operation or none at all. Those who applied none, either left the answer box blank or filled it with one of the numbers given in the equation.

e.g. $\boxed{36} + 3 = 36$ (no operation, gives a given)

$\boxed{12} + 3 = 36$ (wrong operation)

$\square + 3 = 36$ (leaves blank)

2. **INACCURATE COMPUTING**

Here children applied the correct operation inaccurately and obtained an answer that was either one unit or one ten different from the correct answer.

e.g. $46 + 8 = \boxed{55}$ (one unit off correct answer)

$46 + 8 = \boxed{64}$ (one ten off correct answer)

3. **COMBINES ALL GIVENS REGARDLESS OF THE EQUATION SIGN POSITION**

Here children added the given numbers regardless of the equation signs position.

e.g. $6 + \boxed{54} = 48$ (applied addition operation to the two given numbers)

1982 MATHS TEST: ERROR ANALYSIS OF ADDITION ITEMS

Objective	Item	Success Rate (% 692)	Error Rate (% 692)	Frequency of general error strategies (as % of total errors)		
				wrong operation and no operation	in-accurate computing	combines givens
1d + 1d	□ + 8 = 9	92	8	6	9	51
	□ + 8 = 9 (W)*	51	49	23	-	63
	□ + 2 = 7	92	8	16	23	43
1d + 2d	8 + 33 = □	91	9	13	45	-
sum less	8 + 33 = □ (W)	78	22	15	16	-
than 49	36 + 7 = □	91	9	8	46	-
	24 + □ = 33	86	14	4	44	18
	24 + □ = 33 (W)	73	27	24	26	23
	27 + □ = 36	85	15	5	29	19
	□ + 4 = 49	75	25	16	17	22
	□ + 4 = 49 (W)	70	30	39	12	12
	□ + 6 = 24	82	18	11	29	23
1d + 2d	56 + 8 = □	88	12	6	38	-
sum	56 + 8 = □ (W)	83	17	14	21	-
greater	7 + 64 = □	87	13	11	38	-
than 48	72 + □ = 81	87	13	12	36	8
but less	72 + □ = 81 (W)	78	22	28	30	6
than	49 + □ = 57	84	16	11	31	10
100	□ + 5 = 69	73	27	16	26	22
	□ + 5 = 69 (W)	57	43	36	11	23
	□ + 8 = 80	76	24	28	20	16
5 addends to 1 place	2 + 3 + 5 + 2 + 7 = □	93	7	13	39	-
	2 + 3 + 5 + 2 + 7 = □ (W)	87	13	9	73	-
4 addends to 2 places	13 + 8 + 24 + 9 = □	71	29	3	29	-
	13 + 8 + 24 + 9 = □ (W)	68	32	6	34	-

* (W) indicates this item was presented in written form.

ERROR STRATEGIES: SUBTRACTION ITEMS

Eight general error patterns or strategies were found in the 23 item subtraction component of the 1982 Maths Test. They are listed below with examples (sometimes fictitious examples).

1. **WRONG OPERATION OR NO OPERATION**

This strategy was the application of either an inappropriate operation or none at all. When no operation was applied, either the answer box was left blank or filled with one of the numbers given in the equation.

e.g. 18 - 12 = [30] (added instead of subtracted)

18 - 12 = [18] (answered with a given number)

18 - 12 = [ ] (left answer box blank)

2. **INACCURATE COMPUTING**

Here, children applied the correct operation inaccurately and obtained an answer that was one unit different from the correct answer (i.e. one off correct answer). Note that one hundred or one ten off the correct answer indicates a place value error.

e.g. [10] = 19 - 8 (one unit less than correct answer)

3. **ZERO RESPONSE**

Here, children chose zero as a response to items found insoluble or unfamiliar.

e.g. [0] = 44 - 34

Although this error accounted for less than 1% of error responses to all 12 items, it accounted for the majority of errors on two particular items.

4. **REVERSING THE SUBTRAHEND/MINUEND RELATIONSHIP**

When the value of the subtrahend exceeded the value of the minuend, some children chose to reverse the direction of the subtraction operation rather than borrow a ten or a hundred. This indicates a specific bridging difficulty.

e.g.
```
 316
 240 -
 136
```
(reversed direction of subtraction in tens column, hence obtained a difference of 3 instead of 7).

5. **BRIDGING PROBLEM**

Here the strategy was to ignore those parts of an algorism where bridging was necessary and deal only with the other parts. It indicates difficulty with bridging decades.

e.g. 316 (ignored tens column where
260- "borrowing" is necessary)
106

404 (ignored units column)
108-
300

6. **COMBINES ALL GIVENS REGARDLESS OF THE EQUATION SIGN POSITION**

Here children applied the given operation sign to the given numbers in an equation regardless of the equation sign's position.

e.g. 11 - 5 = 16 (subtracted 5 from 16)

7. **SWITCHES OPERATIONS WHEN CHANGING PLACES**

Here children changed operations when changing to a different place value column.

e.g. 404 (added units and tens columns
108 - but subtracted hundreds)
312

8. **PLACE VALUE PROBLEM**

Here children computed answers that were one ten or one hundred different to the correct answer, either because they did not subtract borrowed tens or because they did so inappropriately.

e.g. 65 - 33 = 22 (inappropriately subtracted an extra ten)

1982 MATHS TEST: ERROR ANALYSIS OF SUBTRACTION ITEMS

Objective	Item (W) = Word Version of problem	Success Rate % of 692	Error Rate % of 692	Frequency of General Error Strategies (as % of total errors) **							
				1	2	3	4	5	6	7	8
1d - 1d	□ - 7 = 1	56	44	5	1	1	-	-	86	-	-
	□ - 7 = 1 (W)	80	20	40	3	-	-	-	38	-	-
	□ = 5 - 0	73	27	6	1	82	-	-	-	-	-
	□ = 5 - 0 (W)	86	14	15	19	26	-	-	-	-	-
2d-1d	□ = 14 - 8	82	18	40	20	13	-	-	-	-	-
difference	□ = 14 - 8 (W)	83	17	40	35	2	-	-	-	-	-
less	□ - 3 = 14	71	29	12	15	2	-	-	47	-	-
than 20	□ - 3 = 14 (W)	83	17	53	5	-	-	-	24	-	-
	25 - □ = 18	86	14	6	58	-	4	-	*	-	6
	25 - □ = 18 (W)	75	25	33	36	-	-	-	*	-	11
2d-2d	□ = 18 - 12	81	19	30	22	17	-	-	-	-	6
small	17- □ = 6	86	14	12	36	-	-	-	*	-	-
values	17- □ = 6 (W)	78	22	35	33	-	-	-	*	-	-
than 20	□ - 13 = 6	35	65	9	6	-	-	-	70	-	2
	□ - 13 = 6 (W)	84	16	47	9	-	-	-	21	-	-
2d-2d	86 - 33 = □	86	14	51	6	-	-	1	-	3	12
big values	86 - 33 = □ (W)	71	29	18	12	-	-	7	-	2	8
(less than	65 - □ = 22	57	43	15	12	-	-	-	*	7	12
100)	65- □ = 22	62	38	19	11	-	-	2	*	3	12
no	□ - 52 = 44	27	73	12	2	-	-	-	40	-	-
bridging	□ - 52 = 44 (W)	70	30	28	3	-	-	-	3	2	5
2d-1d	77- 29 = □	51	49	11	6	-	31	15	-	4	15
big values	60- 35 = □	52	48	10	-	-	-	24	-	-	41
bridging											
3d-3d	207 - 109 = □	20	80	9	4	-	26	38	-	6	2
	463 - 276 = □	38	62	9	2	-	24	10	-	-	22

* This error strategy would result here in correct answer.

**Code for General Error Strategies

1 = Wrong operation and no operation.
2 = Inaccurate computing.
3 = 'Zero' response.
4 = 'Reversing'
5 = Bridging Problem.
6 = Combines Givens.
7 = Switches operations.
8 = Place Value Problem.

ERROR STRATEGIES - MULTIPLICATION ITEMS

Eight general error strategies emerged in the 15 item multiplication component of the 1982 Maths Test. They are listed below with examples.

1. WRONG OPERATION OR NO OPERATION

Children applied an inappropriate operation or none at all. Those who applied none either left the answer box blank or filled it with one of the numbers given in the equation.

e.g.	23 x 6 = 29	(added instead of multiplying)
	23 x 6 = 89	(added the multiplier to both the units and the tens column)
	23 x 6 = 6	(gives a given)
	23 x 6 = 23	(gives a given)
	23 x 6 =	(leaves blank)

2. INACCURATE COMPUTING (one off correct answer)

Children applied the correct operation inaccurately and obtained an answer that was either one unit, one ten, or one factor different to the correct answer.

e.g.	23 x 6 = 137	(one off in units column)
	23 x 6 = 128	(one off in tens column)
	12 x 8 = 88	(out by 8)
	12 x 8 = 84	(out by 12)

3. INCORRECT USE OF PLACE VALUE

Children multiplied tens and called them units, or reversed the place value of numbers, or ignored one of the places in a 2 digit number.

e.g.

```
 24 x
  8
 23
160
183
```

(reversed place value of the product of 4 and 8 so 32 is written as 23)

```
 24 x
  8
 32
 16
 48
```

(multiplied tens and called them units)

```
 23 x
  8
 24
```

(ignored the tens column of the multiplicand)

4. SWITCHES OPERATIONS WHEN CHANGING PLACES

Children multiplied numbers in units column and then added the numbers in the tens column -

e.g.
$$\begin{array}{r} 24 \times \\ 8 \\ \hline 32 \\ 20 \\ \hline 52 \end{array}$$
(multiplied units column but added on tens)

5. BRIDGING PROBLEM

Children added carried tens to tens column before multiplying (instead of afterwards).

$$\begin{array}{r} 24 \times \\ 8 \\ \hline 32 \\ 400 \\ \hline 432 \end{array}$$
(added 3 carried tens to the tens column before multiplying by 8)

6. ZERO MISUNDERSTANDING

Children assume that something multiplied by nothing produces something.

e.g. $4 \times 0 = \boxed{4}$

$$\begin{array}{r} 102 \times \\ 3 \\ \hline 336 \end{array}$$

7. REVERSED DIGITS OF ANSWER

Children compute answer correctly but reverse the order of the digits as they write it down.

$4 \times 9 = \boxed{63}$

8. ZERO RESPONSE

Children choose zero as the answer to any insoluble item.

$4 \times 9 = \boxed{0}$

1982 MATHS TEST: ERROR ANALYSIS OF MULTIPLICATION ITEMS

Objective	Item	Success Rate % of 692	Error Rate % of 692	Frequency of General Error Strategies (as % of total errors) **								
				1	2	3	4	5	6	7	8	9
1d x 1d product in range 11-20	5 x 4 = ☐	93	7	37	32	-	-	-	-	-	-	-
	☐ x 2 = 18	74	26	19	61	-	-	-	-	-	-	2
1d x 1d products greater than 20	5 x 9 = ☐	86	14	24	32	-	-	-	-	-	-	-
	5 x 9 = ☐ (W)	75	25	34	19	-	-	-	-	-	-	-
	8 x 6 = ☐	68	32	21	23	-	-	-	-	-	-	-
	8 x 6 = ☐ (W)	60	40	23	21	-	-	-	-	-	-	-
	7 x 6 = ☐ (W)	58	42	41	21	-	-	-	-	-	-	-
	7 x 6 = ☐	72	28	22	33	-	-	-	-	-	-	-
	9 x 7 = ☐	58	42	16	30	-	-	-	-	-	-	-
	12 x 8 = ☐	61	39	22	24	-	-	-	-	-	-	-
	4 x ☐ = 24	81	19	36	20	-	-	-	-	-	-	3
Multi-plicands 13-100, multi-pliers less than 10	32 x 3 = ☐	79	21	30	3	25	14	-	-	5	-	-
	44 x 5 = ☐	59	41	16	-	31	13	10	-	-	-	-
	24 x 8 = ☐	44	56	23	7	20	-	-	-	-	-	-
	50 x 4 = ☐	75	25	38	-	8	-	-	-	-	3	21

** Code for Error Strategies

1 = Wrong operation and no operation.
2 = Inaccurate computing.
3 = Incorrect use of place value.
4 = Switches operations when changing places.
5 = Bridging problem.
6 = Combines givens.
7 = Reversed digits of answer.
8 = Zero response.
9 = Zero Misunderstanding.

ERROR STRATEGIES: CONCEPTS ITEMS

The error strategies which emerged for each of the three types of concepts items tested in the 1982 Maths Test are listed below with examples.

A. FRACTION ITEMS

(1) **SUBSTITUTES FRACTIONS OR GIVES A GIVEN**

Here children either substituted a $\frac{1}{2}$ (or $\frac{1}{4}$) or the given fraction and computes the item accordingly, or chooses the value of the fractions numerator or denominator as an answer.

e.g.	1/10 x 20 = [5]	(substitutes 1/2 or 1/10)
	1/4 x 20 = [4]	(chooses the denominator's value as an answer, or interpreted 1/10 as one lot of four.)

(2) **TREATS DENOMINATOR AS AN INTEGER**

Here children either subtracted, added or multiplied the fractions denominator and the whole number given in the equation.

e.g.	1/10 x 20 = [30]	(denominator added to whole number)
	1/10 x 20 = [200]	(denominator multiplied with number)
	2/5 x 20 = [15]	(denominator subtracted from whole number)

B. MISSING OPERATION SIGN ITEMS

(1) **WRONG OPERATION**

Children chose an incorrect operation to complete the number sentence.

e.g.	4 [−] 2 = 6	(subtraction sign instead of addition sign).

(2) **SUBSTITUTES A NUMBER FOR A MISSING SIGN**

Children put a number instead of a sign in the answer box.

e.g. $3 \boxed{11} 8 = 11$

C. EQUIVALENT EXPRESSIONS (e.g. $3 + 4 = \square + 4$)

(1) **ADDS ALL GIVEN NUMBERS**

Here children added all numbers on both sides of the equation sign to arrive at an answer.

e.g. $3 + 4 = \boxed{11} + 4$

(2) **GIVES GIVENS OR BLANKS**

Here children chose a given number or left the answer box blank.

e.g. $3 + 4 = 4 + \boxed{4}$ (gave a given number)

$3 + 4 = 4 + \square$ (blank)

(3) **ZERO RESPONSE**

Here children responded with zero.

e.g. $3 + 4 = 4 + \boxed{0}$

(4) **IGNORES DIFFERENCES IN SIGNS OR MATCHES NUMBERS IN BOTH EXPRESSIONS**

The title of this strategy is self explanatory.

e.g. $6 + 8 = \boxed{6} - 8$ (either matched the numbers on both sides of the equation or ignored the difference between the operation signs on either side of the equation sign)

(5) **IGNORES EXTRA TERM, OR INTERPRETS THE EQUATION SIGN AS A 'RESULTS' SIGN**

Here children acknowledged only the first 3 elements of the equation and computed their answer accordingly.

e.g. $3 + 4 = \boxed{7} - 12$ (ignored the "-12" term and read the equation as 3 + 4 results in 7)

1982 MATHS TEST: ERROR ANALYSIS OF CONCEPTS ITEMS

Objective	Item	Success Rate (% of 692)	Error Rate (% of 692)	Frequency of General Error Strategies (as % of Total Errors)		
				Substitutes Fraction gives Denominator or Numerator & Blanks	Operates on Denominator as if Integer	Other Specific Errors
Fractions	1/4 x 12 = □	59	41	55	18	
	1/4 x 12 = □ (W)	36	64	51	24	
	1/2 x 16 = □	89	11	33	12	
	1/2 x 16 = □ (W)	69	31	58	17	
	2/5 x 10 = □	13	87	67	34	
	2/5 x 10 = □ (W)	11	89	68	-	21 (unexplained)
	1/10 x 20 = □	41	59	73	8	
	1/10 x 20 = □ (W)	19	81	95	-	

Objective	Item	Success Rate (% of 692)	Error Rate (% of 692)	Frequency of General Error Strategies (as % of Total Errors)					
				Adds all Given Nos.	Gives Givens, Blanks	Zero	Ignores Sign Diffs, or Matches Numbers	Ignores Extra Terms	Inaccurate Counting
Equivalent Expressions same sign	4 + □ = 7 + 4	72	28	41	9	-	-	39	2
	□ + 5 = 5 + 2	73	27	16	20	-	-	45	4
	□ - 4 = 4 - 2	36	64	3	8	-	56	13	2
	□ - 7 = 7 - 3	26	74	2	9	-	37	27	8
As above, but different signs	□ + 4 = 12 - 5	43	57	-	15	-	12	58	7
	3 + □ = 8 - 3	42	58	-	-	-	28	56	2

Objective	Item	Success Rate (% of 692)	Error Rate (% of 692)	Frequency of General Error Stragies (as % of Total Errors)		
				Wrong Sign	Replaced Sign with No.	Blanks
Missing operation signs	17 □ 11 = 6	93	7	29	55	14
	5 □ 8 = 40	87	13	51	35	10
	72 □ 8 = 80	88	12	45	45	6

The results reported in the error analysis tables above show that error rate varied widely in each subscale. It varied from 8% to 49% on the addition subscale, from 14% to 80% on the subtraction subscale, 7% to 59% on the multiplication subscale and 8% to 89% on the concepts subscale. The item error rate varied even for items with similar (but not identical) structure. This indicated that the difficulty of an item could be influenced by one aspect of structure. For example, a consistent finding among the error responses to matched pairs of items in the multiplication and addition subscales was the greater difficulty of the word version of a maths problem compared to its number version. In the subtraction subscale, matched word/number pairs of items showed the reverse trend. In 7 of the 10 pairs of subtraction problems, children were more successful at solving the word version of a problem. Among the several possible explanations for this trend is that a word context enables more children to comprehend and compute subtraction problems than does an algorism, whereas this is not the case for addition and multiplication items. Possibly the difference indicates Year 4 children's greater need for concrete referents when using the subtraction operation than when using addition and multiplication. In these operations, contextual referents may not be required and, when given, may distract children from an automatic adding or multiplying response. Also, a word context provides the opportunity for solving a problem by alternative operations. Hence, a difficult operation can be avoided. For example, children may solve 14 - □ = 6 by counting backwards from 14 until 6 is reached or adding on from 6 in the absence of an operation sign to direct their response to the problem.

As expected, there was also a difference in error rate between big number and small number versions of the same problem in the addition and subtraction subscale. For example -

□ - 3 = 14	31% error rate
□ - 13 = 6	66% error rate
17 - □ = 6	14% error rate
65 - □ = 22	47% error rate
□ + 2 = 7	9% error rate
□ + 8 = 80	27% error rate

This error rate difference suggested that the size of numbers in a number problem can inhibit the application of rational strategies to a task. In the above examples, a group of children who chose the appropriate operation for the problem with small numbers, chose inappropriately for the same task involving large numbers. Typically, they chose to apply the given operation sign to the given large numbers without regard for the position of the equation sign. The influence of number size on problem solving ability can be explained by cognitive development theory. Collis & Biggs (1979) propose that children of this age tend to be able to operate on numbers based only in immediately observable experience. Children tend to find big numbers meaningless because they are not directly related to verifiable experience.

The position of the missing element in an incomplete number sentence, also proved to be a structural variable affecting item difficulty. When number size and problem format are held constant, the error rate for box-first addition and subtraction items

is greater than for box medial items and box last items. Box-last items are easiest of all. This is to be expected since such items are most frequently presented to children in maths lessons, and require a left to right direction of working (which is also the order of the underlying physical manipulation).

The error response data suggests the existence of a hierarchy of difficulty (among both subtraction and addition items) that is based on structural variables (i.e. box position, problem format and number size). The difficulty hierarchy for the subtraction domain appears to be a nested hierarchy with number size as the most important structural characteristic influencing difficulty level, and box position as the next most important, followed by the problem format. Subtraction items featuring big numbers with a box first structure and a number format combine the most difficult possible variations of structure for our Year 4 sample. In the case of addition items, word format and box first position combine the most difficult possible structural variations.

Some items posed specific conceptual difficulties for students and prompted specific error responses. This is true especially for items involving the subtraction of zero, concepts items, and some word items. Items involving the subtraction of zero had a majority of errors in the "zero response" category (170 children made this response to $\square = 5-1$ which is 88% of all those who made any error response). The concept of zero still eludes at least 20% of the sample.

Responses to the fraction items indicated that fractions are either not taught or not understood at Year 4 level. The sample tended to make one of two error responses - either operates on the fractions denominator as though it were an integer (8% of all respondents who made errors); or substitutes fractions/gives denominator or numerator as answer/leaves blank (66% of respondents who made errors).

The equivalent expressions items had a majority of errors in the "ignores extra terms" category. This response indicates that the children interpreted the equation sign as meaning "results in" or "makes" and hence read a sentence like $\square + 4 = 12 - 5$ as "something plus 4 makes 12." A cognitive theory explanation for this interpretation is that children of this age tend to resist the inclusion of more than three elements in a number sentence, and preserve the usual pattern of performing an operation on two elements to obtain a third single element (Collis & Biggs 1979).

The error responses to the missing sign items indicated a similar inertia among a group of at least thirty children. This group replaced the missing sign with a number. The majority of the sample however, demonstrated competence at solving such problems.

SUMMARY

The maths investigation's findings related to its three aims were:

(1) significant achievement differences exist between subsamples and many schools on all subscales and on the total test. The Mt Druitt subsample was shown to be homogeneous in terms of achievement and significantly different to the Contrast group. School differences emerged between pairs of schools from different subsamples. No sex differences were found.

(2) longitudinal change in performance was found on the 11 items common to the 1981 and 1982 tests. Both negative and positive change had occurred.

(3) sample-wide error patterns emerged from the data. Most of these patterns reflect rational attempts at maths problem solving. Three structural elements of maths problems were found to influence item difficulty: box position, problem format and number size. Their influence suggests a hierarchy of difficulty among items. Some error responses identified cognitive difficulties posed by particular structures.

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APPENDIX 1 MT. DRUITT LONGITUDINAL STUDY

1982 MATHS TEST - PART A

NAME: _____

SCHOOL: _____ CLASS: _____

1) 36 + 7 = ☐

2) ☐ = 14 - 8

3) 13 + 8 + 24 + 9 = ☐

4) 9 x 7 = ☐

5) ☐ = 18 - 12

6) 7 + 64 = ☐

7) 5 x 9 = ☐

8) $\frac{1}{2}$ x 16 = ☐

9) 4 + ☐ = 7 + 4

10) 86 - 33 = ___

11) 24 x 8 = ___

12) 207 - 109 = ___

13) 77 - 29 = ___

14) ☐ + 4 = 49

15) ☐ + 5 = 69

2.

16. A postman has to walk 9 kilometres to deliver all the mail. After delivering some letters, he still has 8 kilometres left to walk. How far has he walked already?

17. A cake is cut into 12 pieces. If Bill eats $\frac{1}{4}$ of the cake, how many pieces has he eaten?

18. A bird lays 14 eggs. Eight eggs hatch chickens. How many eggs are left?

3.

19. A girl saves 8 cents one week and 33 cents the next week. How much money does she save in 2 weeks?

20. What is the cost of 5 records at $9 each?

21. John spends 3 cents at the tuckshop and has 14 cents left. How much money did he start with?

22. Sue and John are collecting stamps. Sue has 33 stamps and John has 24. How many more stamps must John collect so that he has as many stamps as Sue?

MT. DRUITT LONGITUDINAL STUDY

1982 MATHS TEST - PART B

NAME: _____

SCHOOL: _____ CLASS: _____

23) $12 \times 8 = \square$

24) $\square + 8 = 9$

25) $72 + \square = 81$

26) $\square - 7 = 1$

27) $17 - \square = 6$

28) $8 \times 6 = \square$

29) $24 + \square = 33$

30) $65 - \square = 22$

31) $\square + 8 = 80$

32) 44×5

33) $463 - 276$

34) $\square + 6 = 24$

35) $\frac{2}{5} \times 10 = \square$

36) $\frac{1}{4} \times 12 = \square$

37) $\square - 3 = 14$

38) $4 \times \square = 24$

2.

39. John and Joan are selling raffle tickets. John has 25 tickets left to sell. Joan has 18 tickets left. How many tickets does John have to sell so that he will have the same number of tickets left as Joan?

40. One half of the 16 books on a library shelf can be borrowed by children. How many books can be borrowed from this shelf?

41. Bob is trying to save 81 cents. He has saved 72 cents already. How much more money must he save?

3.

42. Seven children each ate 6 chocolates. How many chocolates were eaten altogether?

43. Sam weighs 69 kilos. Sue has to put on 5 kilos of weight to be as heavy as Sam. How much does Sue weigh?

44. Anne has 18 cents. She spends 18 cents on lollies. How much money has she left?

MT. DRUITT LONGITUDINAL STUDY

1982 MATHS TEST - PART C

NAME: _____

SCHOOL: _____ CLASS: _____

45) 5 x 4 = ☐

46) 8 + 33 = ☐

47) 25 - ☐ = 18

48) 27 + ☐ = 36

49) $\frac{1}{10}$ x 20 = ☐

50) 56 + 8 = ☐

51) ☐ = 5 - 0

52) 49 + ☐ = 57

53) 7 x 6 = ☐

54) 50 x 4 = ____

55) 60 - 35 = ____

56) 32 x 3 = ____

57) ☐ + 2 = 7

58) ☐ - 52 = 44

59) ☐ - 13 = 6

60) 2 + 3 + 5 + 2 + 7 = ☐

2.

61. Ben has 17 Tic Tacs. Anne has 6 Tic Tacs. How many of his Tic Tacs does Ben have to eat so that he will have the same number of Tic Tacs as Anne has?

62. A book costs 49 cents. Mary had to borrow 4 cents from a friend so that she had enough money for the book. How much money did Mary have before borrowing the 4 cents?

63. Eight children each score 6 points for their team. How many did they score altogether?

64. A group of children go swimming at the beach. Seven of the children go into the water and one child stays on the sand. How many children are in the group?

65. Jean has 2 crayons. Simon has 3, Peter has 5, David has 2 and the teacher has 7. How many crayons altogether?

66. Colour in $\frac{1}{10}$ of this bar of chocolate.

MT. DRUITT LONGITUDINAL STUDY

1982 MATHS TEST - PART D

NAME: _____

SCHOOL: _____ CLASS: _____

67) 17 ☐ 11 = 6

68) 5 ☐ 8 = 40

69) 72 ☐ 8 = 80

70) 3 + ☐ = 8 - 3

71) ☐ + 4 = 12 - 5

72) ☐ - 4 = 4 - 2

73) ☐ - 7 = 7 - 3

74) ☐ x 2 = 18

75) ☐ + 5 = 5 + 2

2.

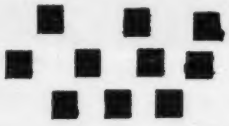
76. A bus stops and lets 13 passengers get off. Then there are 6 passengers left on the bus. How many passengers did the bus have before it stopped?

77. In a game, Player A scores 13 points. Player B scores 8 points, Player C scores 24 points and Player D scores 9 points. How many points were scored altogether?

78. On Monday, 56 children did their homework in 3rd class and 8 children did their homework in 4th class. How many children did their homework altogether?

3.

79. Put a circle around $\frac{2}{5}$ of the squares in this picture.



80. In a ball game, a child has to try and knock down as many blocks as possible from a tower of 5 blocks. One child throws a ball and misses all of the blocks. How many blocks are left standing?

□

81. Jane has 86 swap cards. She gives 33 cards away to John. How many has she left?

□

82. There are 22 children in Mrs. Brown's class. The librarian sends a box of 65 books to Mrs. Brown's class for a reading lesson. How many books will be left in the box if each child takes only one book?

83. Jim's mother gave him some money to buy lunch. Jim spends 52 cents on a pie and a cake and has 44 cents left. How much money did Jim's mother give him?

APPENDIX 2

MT DRUITT LONGITUDINAL STUDY

INSTRUCTIONS TO TEACHERS ON HOW TO ADMINISTER THE 1982 MATHS TEST

The Maths Test is a 4 part test intended for the entire sample of children in the Mt Druitt Longitudinal Study. It is a norm-referenced achievement test designed specifically for the purposes of the Study. Each of the Test's 4 parts consists of 1 page of algorisms and 2 or 3 pages of word problems. All test items relate to operations on counting numbers. They encompass a broad range of skills, some described in the NSW Curriculum for Primary Schools:Mathematics for Year 4 and others for higher and lower years. The children's ability to handle both familiar and unfamiliar maths questions is of interest to the Study.

It is essential for valid results that the Test be given in a standardised way to all children. That is, as far as possible, the Test should be taken by all children under the same conditions. For that reason, how and when the teacher administers the test is crucial to the success of the measurement effect, and conformity to the following set of instructions for test administration required.

The Instructions:

(1) Try to schedule the test for the first thirty-to-forty minutes, on four consecutive mornings, beginning Monday March 14th.
Try to have two test forms ready for each day, in order to minimise chances for children to view each other's work. On Monday, for example, you might give children on the right-hand side of the desks, test form A while distributing test form B to children on the left side. On Tuesday, you could reverse this order whilst handling test forms C and D in a similar way on Wednesday and Thursday. (A and B day 1 and 2, C and D day 3 and 4).

(2) Introduce the task as a maths test to measure what Year 4 children can do in maths. Assure the children that they will be given their test marks in the future. Point out that some questions may be difficult and some may be easy. Each question should be attempted. Even if a question is new and different to what the children are used to doing , they should try and see if they can work out an answer. Number lines, rules and beads or counters may be used if necessary to work out answers but NO HELP MUST BE SOUGHT FROM THE TEACHER OR FROM OTHER CHILDREN. There is a time limit

of 30 minutes for each part of the Test. Please delay explaining how to do test items until the last test part has been completed.

(3) Display a copy of the Test-Part A to the class and draw attention to features such as -

- the space for writing name, school and class.
- the number of pages in the test (3 or 4).
- the type of algorism found on the first page (i.e. complete the number sentence by filling in the box with an appropriate number), and the type of question found on the other pages (i.e. word problems).

(4) Demonstrate how to do the following example of an algorism ,
3 + 4 = ☐ and instruct children on using the space for working under each word problem.

(5) Distribute tests and ask children to fill in name, school and class. Write starting time on board and ask children to start test. After 30 minutes, ask children to stop work. Collect tests. Only assist children in READING questions never in comprehending or computing.

(6) N.B. In part C and D, there are word problems which require the children to colour in or to draw a circle as a response rather than filling in a box. Also, in Part D, there are three algorisms which have an operation sign, rather than a number, as the missing element. Please draw the children's attention to these on days 3 and 4.